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APPLICATION FOR UNITED STATES PATENT

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TITLE: **PORTABLE PLAYER FOR PERSONAL VIDEO
RECORDERS**

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PORTABLE PLAYER FOR PERSONAL VIDEO RECORDERS

TECHNICAL FIELD OF THE INVENTION

The present invention relates to portable video display devices, and particularly to low-cost portable video display devices which reproduce compressed digital video data. The invention further relates to a portable video display device for reproducing compressed video data recorded by a personal video recorder.

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BACKGROUND OF THE INVENTION

Personal video recorders (PVRs) such as provided by Tivo™ and Replay™, are a relatively recent development compared with the older tape-based video cassette recorders. PVRs record broadcast video data in a proprietary compressed video format based on a standard such as MPEG-2, and provide a convenient way to time-shift a broadcast video program. Unfortunately, conventional PVRs are not portable, and thus do not provide a convenient way to "place-shift."

Accordingly, a first object of the present invention is to provide a low cost portable playback device for reproducing compressed digital information at a time and a place different from the time and place of original video reception.

A further object of the present invention is to provide a portable playback device configured to reproduce compressed video information recorded by a PVR.

These and other objects of the present invention are discussed or will be apparent from the detailed description of the invention.

SUMMARY OF THE INVENTION

A low-cost portable digital video player is provided which includes a rewriteable, nonvolatile memory (such as a hard disk), a media decoder, a user input device, and a display. The player receives pre-recorded video information, previously recorded in a compressed proprietary format by a PVR or the like, and either transforms the compressed video information into a nonproprietary format and stores the compressed video information in the memory, or stores the video information in a compressed proprietary format in memory and upon playback decrypts and decompresses the data in real-time prior to reproducing the audio and video data.

10 Preferably, the media decoder is a special function processor which is capable of decrypting the received data into a non-proprietary video format in realtime. The decoder, responsive to instructions received from the player's user input device, retrieves and decompresses the compressed video information, and passes the retrieved and decompressed data to the display.

15 The portable digital video player is provided with at least one of a speaker and a headphone jack for reproducing an audio portion of the video information received from the media decoder of the device.

In a further aspect of the invention, the portable digital video player is provided as a component of a system that also includes a cradle. The cradle has a compressed video data input port, a compressed output data input port, an analog audiovisual input port and an encoder. An input of the encoder is coupled to the analog audio visual input port and produces a compressed video data signal responsive to receiving analog visual data. An output of the encoder is coupled to the compressed video data output port. The compressed video data input port of the

portable player is connected to the compressed video data output port of the cradle when the portable player is docked in the cradle. Conveniently, the cradle also supplies DC power, may have a further storage medium incorporated into it to store further compressed video data, and may have a decoder which is coupled to its compressed video data input port for receiving compressed video data, the decoder decompressing the received compressed video data signal into an analog audio visual signal. Preferably an output of the decoder is coupled to the analog audiovisual output port of the cradle to transmit a decoded analog audiovisual signal to, e.g., a monitor or other display device.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be best understood by reference to the following Detailed Description in conjunction with the drawings, in which like characters identify like parts and in which:

5 FIGURE 1 is a schematic diagram of a low cost portable video playback device according to the present invention;

FIGURE 2 is a more detailed block diagram of a media decoder incorporated into a preferred embodiment of the invention;

10 FIGURE 3 is a diagram showing steps in decrypting one conventional type of proprietary compressed digital video file;

FIGURES 4A and 4B are flow diagrams showing processes for transforming compressed video data;

FIGURE 5 is an isometric view of a portable player according a "notebook" embodiment of the invention;

15 FIGURE 6 is a schematic diagram showing how the portable player of the present invention permits both time-shifting and place-shifting of a broadcast video data file;

FIG . 7 is an isometric view of a "slate" embodiment of a portable player according to the invention;

20 FIGURE 8 is a high-level schematic electrical diagram of a cradle used with the portable player of the invention;

FIGURE 9 is an isometric view of a cradle used in conjunction with a "notebook" embodiment of a portable player according to the invention;

FIGURE 10 is a schematic sectional detail of the cradle shown in FIGURE 9, with a display panel of an installed player shown in an open position;

FIGURE 11 is an isometric view of a cradle into which the "slate" portable player of FIGURE 8 may be docked; and

5 FIGURE 12 is a sectional detail of the cradle shown in FIGURE 11.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENT

FIGURE 1 is a schematic diagram of the low cost portable video playback device according to a first embodiment of the present invention, generally designated 100.

5 The portable video playback device 100 includes a storage medium 102, a media decoder 104, a display screen 106, at least one speaker 108, and a power supply 110. The storage medium 102 should have a storage capacity of at least twenty gigabits of data and be able to write and read data at a rate of at least 1.2Mb/sec. It must also recognize an input data format over a communications 10 channel such as IEEE 1394 or Ethernet. For example, storage medium 102 can be a Quantum 1394 hard drive of a 20G or 30G size.

Storage medium 102 preferably incorporates an output shift register with a serial output. It accepts read/write commands, with addresses, from a media decoder 104 to select disk space for reading or writing.

15 The media decoder 104 preferably is a special purpose processor used to decode and decompress compressed video data in real time. According to one embodiment, the media decoder 104 performs a preliminary step of decrypting the data prior to storing the data in compressed form on the storage medium 102. Alternatively, the storage medium 102 stores the data in the format recorded by a 20 PVR 116, and the media decoder 104 decrypts and decompresses the data in real time (on-the-fly) prior to the output of same to a display and an audio output.

FIGURE 2 is a detailed block diagram showing the minimal functional requirements of a media decoder 104 capable of carrying out the invention. The media decoder 104 preferably is built around a reduced instruction set chip (RISC)

CPU 300 that is preferably programmed with a real time operating system (RTOS). CPU 300 should be able to process at least 33 million instructions per second (MIP/S). In the illustrated embodiment, the CPU 300 communicates with an IEEE 1394 firewire circuit or physical layer 302 and an analog audio/video interface circuit 304. Alternatively, the IEEE 1394 interface circuit 302 may be replaced by an Ethernet interface circuit, or both of these kinds of data port interfaces or even other interfaces could be present in order to give the user flexibility in choice of data input. A small cache memory 306 (such as 16K) is used to hold that portion of the compressed data stream that is presently being processed by decoder 300. The media processor 104 also needs an address memory 308. Communication to the graphical user interface, display and audio output is made through a serial input/output controller 309.

According to a preferred embodiment, a C-Cube™ DoMiNo™ network media processor is used for the media decoder 104. This decoder 104 is optimized for decoding MPEG-2 data. The DoMiNo™ network media processor has far more capability than is actually needed to perform the functions minimally necessary for carrying out the invention, but it is self-contained and relatively inexpensive.

Returning to FIGURE 1, and according to a preferred embodiment, the display 106 is a touch screen which serves both as an input device and a display screen; however, a separate, dedicated input device 106a such as a touch pad or mouse may be added. The display 106 may incorporate an ion emission plate, plasma screen or other flat panel technology. Preferably, the display 106 has a low rate of power consumption, and is lightweight and robust. Particularly preferred for display

106 is an ion emission plate; these display devices exhibit excellent visual characteristics (they can be viewed from widely different angles) and have relatively low power consumption. Display 106 should be at least 8" x 5" and more preferably is 10" x 8" in size. In one embodiment, display 106 is sized to receive typical movie formats.

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The display 106 minimally should be able to reconstruct at least television-quality imaging. It should have a refresh rate of 60 frames/sec. or greater. Display 106 can be, for example, 640 x 480 pixels, 720 x 486 pixels, or 1920 x 1080 pixels.

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The speaker 108 may be any conventional low-power speaker such as is known in the art. The speaker 108 may be replaced by a headphone jack 108a. Alternatively, both a speaker 108 and a headphone jack 108a may be provided.

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The power supply 110 may be a conventional battery. Preferably, the battery 110 has a rechargeable chemistry such as lithium ion, NiCad or nickel metal halide and has sufficient voltage and capacity (such as 50 watt-hours) to power the components of player 100 for a length of time that is on the same order of magnitude as the length of play of the video data which can be recorded on storage medium 102.

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Preferably, the power and most input and output communications of the player 100 are routed through a cradle 120, which will be described in further detail below.

The portable video playback device 100 is adapted to receive compressed video data from a conventional PVR 116, a personal computer 117, over a local area network (such as an Ethernet) 204, over a wide area network which may consist of or include the Internet, or from wireless sources by way of an antenna and

an RF receiver (not shown). In operation, the portable video playback device 100 receives compressed data, which is stored (either in encrypted or decrypted format) on the storage medium 102. The media decoder 104, upon receiving appropriate commands from input device 106, selects all or a portion of the compressed video data stored on disk 102 for retrieval, decompresses this video data, and passes the decompressed data streams on to the display 106 and audio outputs 108/108a.

The PVR 116 stores its compressed video files in a proprietary format, which must be converted at some stage by the portable video playback device 100. Video data may be transmitted from the PVR in packets with embedded MPEG 2 data.

The PVR 116 may modify a public compression standard such as MPEG-2 by providing a header on each file, by encrypting the file by a known hash algorithm, or both. According to the invention, whatever modifications the PVR makes to the standard compressed video format, the portable player 100 removes. As noted previously, the personal media player 100 may store compressed data in the storage medium 102 using the proprietary PVR format, or may decrypt the data and store decrypted, compressed data in the memory 102.

The decoding algorithms employed by decoder 104 are matched to the proprietary video format made available by the PVR 116. The compressed data may be stored on the storage media 102 in a variety of formats such as MPEG-1, MPEG-2, MPEG-4, MPEG-7 or AVI, as are known in the art. While it is preferred that the compressed data be converted from the proprietary and/or encrypted PVR format prior to being stored on the storage medium 102, this conversion could be performed upon retrieval.

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FIGURE 4A illustrates a representative process for decrypting a compressed video data file out of a proprietary format into a standard compressed video format such as MPEG-2. One such proprietary format is shown at 700 in FIGURE 3. This data file 700 has a header 702 and a compressed video content portion 704. At predetermined positions within the header 702 are a start address byte S and a length byte L.

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At step 301 in FIGURE 4A, the portable video player receives and recognizes a compressed data file such as file 700 in FIGURE 3. A beginning portion of file 700 is stored in a buffer while file 700 is being decrypted. At step 340 a file header structure, which can be stored in a nonvolatile memory component (not shown) of decoder 104, is retrieved by the decoder 300. The file header structure is used at step 342 to determine where a start address byte S and a length byte L are positioned in the header 702. The decoder 104 then reads the start address byte S and the length byte L from these locations.

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Knowing the start address byte S gives decoder 104 an offset, as measured from the beginning of the file 700, to where the compressed video content begins at start address position ST. The length byte L is used to determine the length of the compressed video content. Now knowing the start address and length, at step 344 the processor or decoder 104 starts copying the video content portion 704 of file 700 into another sequence of memory locations 706. The processor 104 therefore has available to it a conventional compressed data file to copy onto storage medium 102, which it does at step 346 (FIGURE 4A).

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FIGURE 4B is an alternative process flow diagram showing how an the input proprietary data file is processed according to a second embodiment of the

invention. At step 601 a data file is received and is stored on mass storage medium 102 as a media file. At step 602, a command is received, instructing the media decoder 104 to retrieve the media file. The media decoder temporarily stores portions of the file in the memory cache 306 (FIGURE 2) as the CPU 300 operates on it. At 5 step 640 the data file is decrypted, as by applying a predetermined key to it in the instance that an encryption algorithm had been applied to the data file by the PVR prior to transmission. At step 642, a beginning, predetermined, proprietary header as above described is effectively stripped from the decrypted data packet by copying only the video content of it to another memory location. At this point (644) the data 10 file, still in a compressed format such as MPEG-2 or the like, is decompressed into analog audio and video components and is ready to be streamed to the display 106 and to the audio output.

The embodiment illustrated in FIGURE 4A presupposes that the proprietary format transmitted by the PVR 116 will not be encrypted as by a hash 15 algorithm but will be associated with a proprietary header. The process outlined in FIGURE 4B assumes both decryption by a key and removing a header. It is also possible to provide a system in which only hashing and keyed decryption occurs. Dehashing and header stripping can occur entirely or partly before or after storage on storage medium 102.

To contain cost and minimize complexity it is preferred that the 20 portable video playback device 100 be strictly a playback device, which would not provide recording capability other than that necessary for receiving the proprietary input data stream. Accordingly, functions of the media decoder 104 are optimized for

transforming and decompressing data. In less preferred embodiments the player 100 could have broader read/write capabilities.

FIGURE 5 shows a first representative physical embodiment 100a of a portable media player. The first embodiment 100a takes a "notebook" or "laptop" form in which a screen panel 400 is hinged to a lower panel 402 via a hinge 404. While the player 100 looks like a laptop computer, it is lighter, consumes less power, and is far less expensive than laptops now made, because the required logic, electronics and peripheral devices are much simpler. Further, laptop personal computers now made are not equipped to decrypt proprietary PVR video formats. The "laptop" embodiment 100a is advantageous because it provides a method for the user to protect the screen 106 when not in use by folding it down onto, and securing it to, the lower panel 402.

Lower panel 402 includes the storage medium 102 (not shown in this figure), the speaker 108, and a touchpad 106a. In the illustrated embodiment, PLAY, DEL and LOAD keys are shown in the lower panel 402. These functions could alternatively be implemented in areas of the touch screen 106. Panel 402 also includes the headphone jack 108a and the IEEE 1394 firewire or other compressed video data port 320 for loading the video data that is to be desired to be played later.

In FIGURE 5, an introductory screen is illustrated showing the titles of the various video clips which have been loaded onto the storage medium. Scroll arrows 406 and 408 may be touched by the user to scroll through the entire content of the storage medium. One of the titles will be highlighted, as is shown at 410. Pressing the DEL key will delete this title, thus freeing up the storage space devoted to it. Pressing the PLAY key will begin the playback of this clip.

In a loading sequence, onboard logic contained within player 100 inspects which clips have been stored on the PVR (not shown) and permits the user to select which of these should be copied onto the storage medium of the portable player. In a load mode, the screen 106 shows possible titles which are available for loading from the PVR. A selection as by highlighting of one of these and pressing the LOAD key causes this compressed video clip to be loaded. Appropriate software monitors available storage space on the storage medium 102 and reports if the size of the video clip that is desired to be loaded exceeds available space in the player.

In place of the single speaker 108 shown, stereo speakers could be provided with maximum spatial separation between them. Such an embodiment is shown in FIGURE 7. The "slate" portable player embodiment, indicated generally at 750 has a flat panel display 752, preferably an ion emission plate. The dimensions of display 752 can be approximately 8 x 10 inches, or slightly smaller than this so that the entire dimensions of the slate embodiment 750 are 8½ x 11 inches. Alternatively, the display 752 can have proportionate dimensions which match typical analog video movie formats, such as 3:4, to fit a 1200 pixel high by 1600 pixel wide format.

In this illustrated embodiment, the display 752 is also a touch screen, and all of the functionality associated with the portable player 750 is controlled by pressing various portions of the display 752. On a side 754 of the portable player 750 a power button 756 can be placed. The side 754 can also have an audio headphone jack 758 for headphones. These controls and data ports are preferably placed near an upper end of the player 750, as shown. A portion of the front surface 760 can be occupied by separated speakers 762. A multiple pin connector 764 may be built into a bottom surface 766 of the case 768. For stability while disposed in a cradle

(described below), it is preferred that the heavier electronic components of the portable player 750 occupy the lower two thirds of the volume of the case 768, closer toward bottom surface 766.

Both the "laptop" and "slate" embodiments of the portable players according to the invention are designed to be used with a respective type of cradle 120, schematically illustrated in FIGURE 8. The cradle 120 provides a base for the portable player 100 and is designed to physically receive it, as will be described below. The cradle 120 provides a permanent connection to external power and data communications. Compressed video data, as from a personal video recorder, is received on a compressed video data port 122. Analog audio visual signals can be received at an analog audiovisual signal data port 124, which includes two audio channels and one video channel. The analog audiovisual signals are input to an encoder 126, one output of which is connected to a multiplexer 128 and to a further mass storage medium 130, such as a hard disk or other read/write memory device with a large capacity. Multiplexer 128 has an output which is connected to a first input of a multiplexer/demultiplexer 132. An output 134 of multiplexer/demultiplexer 132 is connected to the compressed video data input port of the portable player 100.

A second input of the multiplexer/demultiplexer 132 is connected to an output of the storage medium 130. A second output of circuit 132 is connected to a decoder 136, which is operable to decode a compressed video data signal into analog audiovisual signal format. An input 138 of a multiplexer 140 is connected to an analog audiovisual output port of the portable player 100. One input of the multiplexer 140 is connected to the decoder 136. An output of multiplexer 140 is connected to an analog audiovisual output port 142 of the cradle. This output port

may be connected to conventional display and audio devices. A processor 144 controls the operation of encoder 126, storage medium 130, multiplexer 128, multiplexer/demultiplexer 132, and multiplexer 140. A power input port 146 transforms and rectifies AC power and serves as a power supply for the cradle electronics as well as a recharging power source for battery 110 (Fig. 1).

Figure 9 and 10 show an exemplary physical embodiment of a cradle 120a which is meant to receive a "laptop" personal video player 100a. In this embodiment a lower panel 402 of the portable video player 100a rests on a horizontal, flat receiving face 420 of cradle 120a. A depth of face 420 is intentionally less than that of panel 402 so that a user may grasp the protruding ends of panels 400 and 402 for ease in extraction. Left and right walls or arms 422 and 424 have chamfered interior sidewalls 426, 428 for ease in insertably guiding the player 100a toward a rear player connection panel 430, into which a multiple-pin electrical connector 432 is mounted. This connector 432 receives respective pins of a rear connector 434 of player 100a.

The user may wish to view player 100a while it is docked in cradle 120a, and for this reason the cradle 120a has a recess 436 and a sloped surface 438 to permit the opening and support of panel 400 in and to an open position. Base 440 of the cradle 120a is made thick enough to house storage medium 130. A rear electrical connector 442 is used to connect the cradle 120a to AC power, at least one compressed video data source, and optionally one or more video playing devices with analog audio and video lines.

A second physical embodiment 120b of the cradle is shown in Figures 11 and 12. A "slate" video player 750 is inserted into a receptacle formed by a back

upstanding wall 800, left and right side panels 802, 804 left and right front flanges 806, 808, and a bottom receiving surface 810 into which a multiple-pin electrical connector 812 is mounted. This receptacle props up the portable player 750 to a viewable position. The top margins of walls 802, 804, 806, 808 are curved or sloped to ease the slidable registration of the player 750 into the receptacle. Walls 800-808 are preferably more than half, but less than all, of the height of player 750 so that player 750 may stably reside in the cradle 120b but be easily removed from it. The flanges 806, 808 must not be so wide that the area of screen 752 is occluded.

A base 814 of the cradle 120b provides space for a disk or other mass storage medium 130. As in cradle 120a, a multiple-pin electrical connector 442 is mounted to a rear panel 816 to provide connector to AC power, at least one source of compressed video data in a predetermined format, and possibly other remote devices.

FIGURE 6 is a schematic diagram showing how the invention permits both time-shifting and place-shifting of a broadcast video data file. The personal video recorder 116 can receive television signals or other video signals from such sources as direct UHF or VHF through antenna 500, a satellite dish 502 or a cable 504. An on-board receiver in the personal video recorder 116 can be used to pick up these signals, or alternatively a receiver module of an associated television set 506 may be used to pick up the video signals. The PVR 116 has the capability of time-shifting and compressing these video data signals to permit the user to play them back at a time other than their initial broadcast.

According to the invention, the PVR 116 has a compressed video data output port, such as an IEEE 1394 firewire output port 508, which the user may connect to the input port of cradle 120. The player 100 is initially docked in cradle

120. The user can then download selected tracks or data files from recorder 116 onto the portable media player 100. The user then removes the player 100 from the cradle 120 and transports the portable media player with him or her, as shown, to play at his or her leisure at a remote location. This permits the playback of a video data file as shifted both in time and in space.

5 While various embodiments of the present invention have been shown and described, it should be understood that other modifications, substitutions and alternatives can be made without departing from the spirit and scope of the invention, which should be determined from the appended claims.